THE TiC/TiO_2 INTERFACE

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Since several years the behaviour at high temperatures of refractory carbides in oxidizing atmospheres has been studied because of the important technological applications of these materials. In fact, their excellent mechanical (for instance, hardness) and physical properties (for instance, high melting point) make them peculiar materials for high performance applications under extreme operating conditions. Some of these applications require working at high temperatures in air or moisture containing enviroments where the reactivity of refractory carbides can be very high causing the destruction of their high mechanical stability. On the other hand, the growth of a thin and adherent layer of the parent oxide on the refractory carbide sample can satisfy the requirements of both preserving the mechanical properties and protecting against the hot corrosion. One of the way to realize this, it is the control of the reactivity of a refractory carbide when it is left to react at high temperatures and low oxygen partial pressure.

Some papers have been published by our group in the field[1-3] and, more recently, the work has been addressed to the investigation of the reaction mechanism and, particularly, to the chemical nature of the refractory carbide/parent oxide interface. The study has been performed on single crystals, mainly on TiC single crystals[4-5].

The reactivity has been measured by a home-made device based on two identical solid electrolyte oxygen sensors connected to a Quadrupole Mass Spectrometer (QMS) (see Fig. 1). The TiC substrate and oxidation product grown, TiO_2 (rutile), have been already well characterized by XRD texture analysis[5] to understand the structure relationships between TiC and rutile when TiC single crystal with different orientations are oxidized. In order to investigate the TiC/TiO_2 (rutile) interface, SEM, micro-Raman (see Fig. 2) and Auger coupled to SEM techniques have been used to detect the composition profiles along the cross-section of the interface. The results obtained as well as the proposal of a model of reaction kinetics will be presented.

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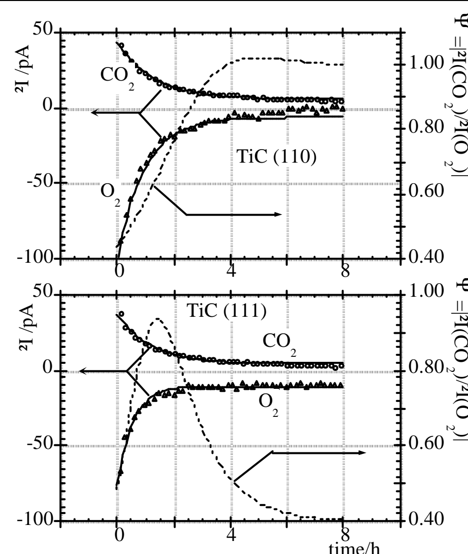

Fig. 1
Left ordinates: QMS signals of O_2 and CO_2 and best-fitting curves. Right ordinates: quantity Ψ given by the ratio $|\Delta I(CO_2)/\Delta I(O_2)|$.
Time interval is equal to the length of the isotherms.
T = 1073 K, 270 ppm of O_2 in Ar at 2 bar abs.

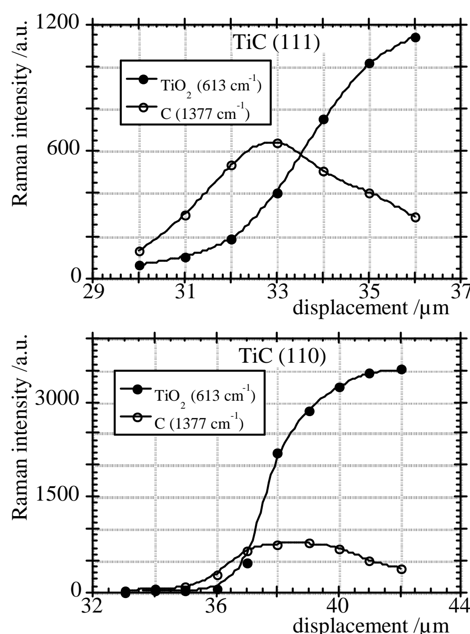

Fig. 2
Micro-Raman intensity profiles of rutile and amorphous carbon taken at their most intense peak, respectively, at 613 and 1377 cm^{-1} as function of the displacement along the cross-section of the reacted region. The origin of the displacement axis is in an arbitrary point in the bulk of TiC where no micro-Raman signal is detected. Lower scan numbers refers to the TiC/ reacted region interface. Higher scan numbers to reacted region/gas interface. The uppermost figure is a scheme showing the position of the sample during the oxidation and the position of its cross-section in the micro-Raman profile analysis.

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